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Development of TPACK-Contained of Light Properties Teaching Materials for Grade IV Elementary School Students

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Abstract

The teaching materials used by students only based on student books and certain printed worksheets as learning resources and regardless the student's character in delivering the materials. Teaching materials that have not been able to increase students' interest in learning of our school. The purpose of this study was to develop teaching materials for the properties of light with Technological Pedagogical Content Knowledge (TPACK) approach in science learning, determine eligibility criteria, and the effect of implementing teaching materials to increase student interest in learning. The research model uses the Sugiyono (2018) development design which is modified into three stages, namely preliminary studies, development, and implementation. Data analysis techniques in the research process include feasibility analysis of teaching materials, N-gain test and Mann Whitney Nonparametric Test to determine the effect of teaching materials on student interest in learning. The results of the study show that (1) the results of validation by experts and practitioners of teaching materials on the properties of light charged with TPACK with an average of 89.53% with very feasible criteria (2) the results of implementing teaching materials can increase students' interest in learning science. This result is evidenced by the average N-gain of the experimental class students of 0.54 (moderate) and the control class students of 0.26 (weak). The results of the Mann Whitney Nonparametric Test obtained the Asymp Sig value < 0.05, then Ho was rejected, this means that there is a significant increase in student interest in learning by using teaching materials for the properties of light with TPACK contain.

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INTRODUCTION

The main purpose of learning science is to provide basic knowledge and experience for students to understand their environment scientifically in everyday life. The purpose is in line with Tyas et al. (2020), who states that science learning is an effort to study scientifically about everything related to natural phenomena that occur in the environment in everyday life. According to the OECD as quoted by Widiyanto et al. (2015), in order to be able to have good understanding, knowledge and skills in science, students must have science competence skills, namely scientific literacy. Scientific literacy is the ability to understand, identify, evaluate and conclude everything scientifically related to the environment and everyday life. However, this has not been implemented well in the science learning process in elementary schools in general. The results of the TIMMS survey released in December 2016 showing Indonesia's learning achievement is in the five bottom with a score of 397. A similar statement was also released by PISA in 2018 showing that Indonesia's survey results ranked 74th in the science category from 80 participating countries.

Based on the results of field observations carried out in several schools in the Bancar sub-district, information was obtained that the average value of science learning is still much below the specified minimum completeness criteria (KKM), which is 70. One of the materials in science learning and it has an average value of formative tests the lowest is the material properties of light in grade IV students. The results of the recap of grades from the four schools as a field study with a total of 68 students showed 28 students had completed learning and 40 did not complete learning. This indicates that students' interest in learning to increase students' abilities is still low. This condition is same with the research of Karina et al. 2017, that learning outcomes are strongly influenced by student's interests in the learning process. More low student's interests in learning, the results obtained in learning are also low and vice versa. Another opinion was also stated by Rozikin et al. 2018 states that students' interest in learning will influence students to obtain the knowledge learned.

Another result of the observation activity shows that in the teaching and learning process the teaching materials used in the learning process are only from student books and teachers' books for the 2013 curriculum and certain printing worksheets as a guide for students. So, this influence the student learning process because the books held by students have several shortcomings, for example there are some aspects of the appearance that are less attractive and some presentations of learning activities that have not been structured according to the science concept. This situation becomes a special problem that causes students have difficulty in learning.

One of the innovative efforts to minimize problems in science learning is to carry out an innovation and development in the form of teaching materials to support student interest in learning activities at school. According to Melindawati (2019), to achieve good learning outcomes, teaching materials are needed that are able to motivate students and facilitate student learning activities. This is in line with the opinion Desyandri et al. (2019), to create an interesting learning, creative and innovative steps must be taken, one of which is through the development of teaching materials as learning resources that can have an impact on learning.

Of course, in the process of developing learning resources in the form of teaching materials, teachers must be selective and innovative and selective in choosing the concept of teaching materials. The development of teaching materials is expected to be able to provide facilities for students to be able to encourage optimal learning both independently and in groups. Teaching materials are said to be effective if the arrangement of teaching materials contains a series of learning processes that are designed systematically including learning materials, methods, and ways of evaluating in order to achieve the expected goals (Hadianto et al., 2018).

Teaching materials are materials or tools that can package a learning material, strategies, methods and steps and evaluation techniques in a systematic and interesting way (Anis et al., 2021). Teaching materials are developed in accordance with the concept of science learning which includes a series of learning including content, context, scientific processes, and attitudes in the hope that they can support creative, collaborative, and effective scientific skills (Sugiyarti et al., 2018). The development of teaching materials must be adapted to the development of the times and the character of students to make it easier to solve problems in learning. Referring to research from Huda et al. (2017), respondents from their research show that more than 80% expect the need for the development of books containing TPACK. Another study from Putranti. (2020), 2013 thematic textbooks for elementary school students had a very low TPACK content. So, it is necessary to develop teaching materials containing TPACK as an innovative step.

The development of teaching materials containing TPACK is packaged with technological, pedagogic, and material content as solutions in learning. The TPACK framework is structured as a learning framework that combines technology, pedagogy and materials to support the learning process(Özgur, 2020). Other opinions are also conveyed Mairisiska et al. (2014) learning by presenting elements of technology combined with learning materials can increase student motivation in exploring. The concept of technology aims to train students to use technology in the learning process by expanding the sources of information provided by teaching materials via the web in the form of using links. Pedagogy as an approach to presenting teaching materials with contextual, scientific and guided inquiry concepts that are able to guide students in learning independently and classically. The content of teaching materials is developed according to the material properties of light that are packaged accurately and in depth.

The development of teaching materials containing TPACK is carried out by Purnawati et al. (2020), that learning by integrating TPACK will have a positive impact on students, especially in motivating students to participate in learning activities. This can be seen from students' interest in the material being studied and changes in student behavior who are very interested in mastering the material presented by the teacher. Other research was also conducted by Aulia et al. (2021), who concluded that using the TPACK-loaded module could improve scientific literacy learning outcomes. Of course, the learning outcomes cannot be separated from the interest of students when learning takes place.

Learning objectives will not be achieved without student interest in learning. Interest is something that has an impact or influence on students in learning (Ho & Devi, 2020). Interest in learning can be measured from several indicators such as interest in learning, attention in learning, and motivation or feelings of pleasure (Rozikin et al., 2018). One of the factors that influence interest in learning is the use of teaching materials combined with the concept of Technology, Pedagogy, and Content Knowledge can enrich students' ideas or ideas so that students are more motivated to activities carried out by students to explore their creativity. The development of teaching materials that are packaged scientifically and combined with materials, illustrations, student activities, exercises/evaluations and ICT resources in learning can increase students' learning motivation and increase literacy skills in understanding learning materials.

Based on the facts above, it is important to conduct research on the development of teaching materials on the properties of charged light with TPACK for grade IV elementary school students. The objectives of the research and development of materials are (1) to analyze the feasibility of the results of the development of teaching materials for the properties of light charged with TPACK, (2) to analyze the effect of the implementation of the results of developing teaching materials for the properties of light charged with TPACK on students' interest in learning science. It is hoped that the

development of teaching materials can provide benefits and can facilitate teachers in carrying out the learning process so that learning objectives can be achieved.

METHODS

This research is a Research and Development (R & D). The research design for the development of teaching materials was adopted according to Sugiyono (2018:298) includes analyze the potency and the problems, collect the informations, product design, validation design, revision design, product trials, product revision, product usage test, product revision and the product usage extensively. That stage modified by the researchers into three stages, namely the preliminary, development and implementation stages. The preliminary stage consists of a literature study and a field study. The development stage includes preparing the design of teaching materials, validation and testing. The implementation stage is a broad-scale test of the developed teaching materials.

Research and Development aims to analyze the feasibility of the teaching materials developed and to examine the effect of the implementation of teaching materials on students' interest in learning by using teaching materials with the properties of light charged with TPACK.

The development research was carried out at three schools in the Bancar sub-district, namely Ngujuran State Elementary School 02, Karangrejo State Elementary School 02 and Cingklung State Elementary School. Ngujuran State Elementary School 02 as an experimental class with a total of 29 students, Karangrejo State Elementary School 02 as a control class totaled 13 students and Cingklung State Elementary School amounted to 13 as a test class of teaching materials before being implemented. Based on the results of field studies, these schools do not yet have complementary teaching materials for the properties of light that are charged with TPACK and the teaching materials used are still centered on student books and certain printed worksheets.

The analysis of the feasibility of teaching materials includes four aspects of the criteria, namely: content feasibility, display feasibility, and language and TPACK content feasibility. The four aspects are translated into several indicators of assessment of teaching materials. Expert and practitioner validators assess teaching materials using a four-point scale, namely very good (4), good (3), poor (2) and very poor (1). The results of the assessment scores are summed and converted into a percentage. The percentage results obtained are then interpreted with the eligibility criteria for teaching materials according to (Mulyani et al., 2021). Teaching materials are said to be valid if they reach an average of 60% with a decent category. Prior to the trial phase, the teaching materials were revised in accordance with the input of expert and practitioner validation.

Analysis of the effectiveness and influence of teaching materials is carried out at the trial and implementation stages. The testing phase of teaching materials carried out data analysis in the form of average learning outcomes, analysis of student learning activities and student responses. The implementation of teaching materials aims to determine the effect of teaching materials on the learning interest of fourth grade elementary school students with the N-gain average test and Mann Whitney nonparametric comparison test. Implementation analysis uses student interest questionnaires given before and after using teaching materials on the properties of light charged with TPACK with the Pretest-Posttest Control Group Design method. The questionnaire instrument used in the previous implementation had gone through the content validation stage by experts and practitioners and was tested first to determine the validity and reliability.

RESULTS AND DISCUSSION

Research and development begins with a preliminary study to obtain information about learning activities in elementary schools. The

information includes the ability of teachers in learning in the classroom, especially in applying the TPACK learning framework, teaching materials used in learning, learning facilities, and student learning outcomes as well as conducting several KI and KD analyzes of the material properties of my hero theme light for grade IV students in the curriculum. 2013. Based on the preliminary study, concluded that there should be complementary teaching materials that support students in learning science, especially on the material properties of light. Teaching materials are expected to provide new vehicles for students both in terms of design / appearance, material accuracy, language and TPACK content as supporting student activities for information by utilizing technology sources in an interesting way.

The teaching materials developed in the study were compiled with the TPACK framework concept printed in the form of textbooks as a source of student learning. TPACK content is arranged in teaching materials so that TPACK indicators can be fulfilled and make it easier for students in learning activities. The TPACK indicator includes seven TPACK components according to Koehler et al. (2013), namely Content Knowledge (CK), Pedagogical Knowledge (PK), Technological Knowledge (TK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK) and Technological Pedagogical Content Knowledge (TPACK). Prototypes of teaching materials must meet several elements of teaching materials such as the design and appearance of attractive teaching materials, teaching materials are accurate and instructional, able to train students' knowledge and experience, test student understanding, adjust student development, and use correct and clear grammar.

The following are the results of the development of teaching materials for the properties of light loaded with TPACK which are presented in the student companion book which includes thirteen constituent components, including:

1. Cover material contains the title of the material, material, class and author.
2. The preface contains gratitude, thanks to the guidance lecturer and validator.
3. Table of contents.
4. Description of the teaching materials developed.
5. A brief guide to the use of teaching materials for the properties of TPACK-charged light.
6. Description of student learning activities in the form of a brief description of the objectives of each learning activity.
7. Competency mapping: KI, KD, learning objectives.
8. The scope of the material developed in the teaching materials.
9. Learning opening page.
10. TPACK loads are represented in TK, CK, PK, PCK, TCK, and TPK posts.
11. Distribution of Sub-chapters consists of "Let's observe, Let's reason, Let's find out, Let's try, Let's conclude, Let's practice and Let's contemplate."
12. Glossary: explanations related to difficult terms in teaching materials
13. References.

The results of the development of teaching materials carried out a validation test, namely the validation of experts and practitioners. Expert validation was carried out by expert lecturers from Semarang State University and PGRI Ronggolawe University Tuban. Practitioner validation was carried out by school supervisors, principals and teachers in Bancar District, Tuban Regency. The recapitulation of the results of expert validation and practitioner validation of teaching materials on the properties of light charged with TPACK obtained an average score of 89.53% with very feasible criteria. This shows that the teaching materials of the properties of light are suitable for use in research at the next stage. The results of the recapitulation of the validation of teaching materials are shown in Table 1.

In the validation process there are several suggestions and input by the validator. These suggestions and inputs are used as a reference for revision of the improvement and

improvement of teaching materials. Suggestions and inputs from the validators include some unattractive displays, some inappropriate TPACK content, some pictures are no pictures yet, some sentences using too dense language and inappropriate punctuation. The results of the revision were then consulted with the validator and supervisor before the trial phase of teaching materials was carried out in the trial class. Teaching hand out revision after expert validation shown in Figure 1 and Figure 2.

Table 1. Expert and Practitioner Validation Results

Indicator	Expert validators (%)		Practitioner Validator (%)				
	V1	V2	V3	V4	V5	V6	V7
Content eligibility components	78.85	88.46	80.77	88.46	100	86.55	92.31
Components of presentation eligibility	92.50	97.50	82.50	97.50	95.00	90.00	92.50
Language eligibility components	80.00	95.00	100.00	85.00	85.00	85.00	87.50
TPACK Load	85.94	89.06	78.13	92.12	100.00	90.63	90.63
Average	84.32	92.51	80.35	90.79	95.00	84.04	90.73
Combined average	89.53						
Criteria	Very feasible						

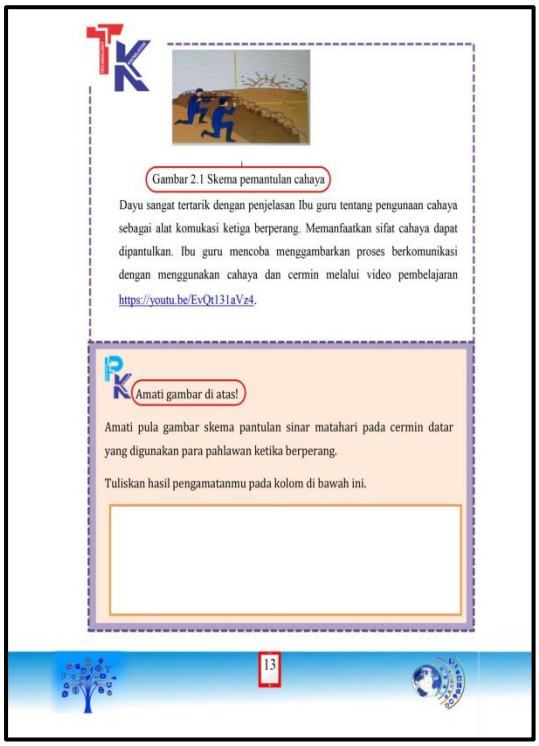

Figure 1. Teaching Material Before Validated

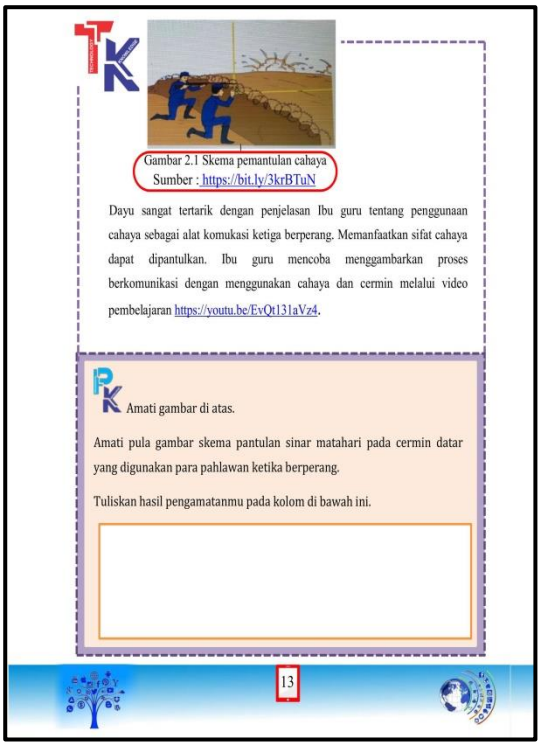

Figure 2. Teaching Material After Validated

Based on the results of the revision shown in Figure 1 and Figure 2, there are several revisions after validation including photos/images that are not the product itself, it

is necessary to give a source from where the image was taken. Language should be more refined, concise and pay attention in using of punctuation marks.

The trial of teaching materials on the properties of light aims to determine the effectiveness of teaching materials before they are implemented in the experimental class. Before conducting the trial, it is necessary to develop research tools in the form of lesson plans and research instruments. The research tools are arranged according to the research concept with the indicators needed in the research process. The results of the validation of research tools by experts and practitioners are presented in Table 2.

Table 2. Research instrument validation results

Research Tool	Validation Results	Information
RPP Validation	91.81%	Valid
Validation of interest questionnaire	91.00%	Valid
Interest questionnaire trial	Validity	Valid
	Reliability	Reliable
Validation of test questions	90.44%	Valid
Test questions test	Validity	Valid
	Reliability	Reliable
	Different Power	Accepted
	Difficulty level	Accepted
Student activity sheet	Expert	Valid
Response Questionnaire	Expert	Valid

Limited trials of teaching materials for the properties of light charged with TPACK were carried out with the aim of knowing the shortcomings and constraints as well as the effectiveness of teaching materials in the learning process. According to Melindawati (2019), teaching materials are said to be effective and practical if they can be used easily and by students and teachers and can achieve learning objectives. The trial process is also to obtain input and suggestions from teachers as experienced practitioners in learning. Analysis of teaching materials during trial activities was carried out on learning outcomes, observing student activities in learning and student responses. Learning outcomes in the trial class were seen from the results of the pretest and posttest. At the time of the pretest only 4 students who finished studying with an average learning outcome of 55.38 while the posttest number of students who completed the study amounted to 8 students with an average score of 74.36. The N-gain learning outcomes of the trial class obtained an average of 0.54 with moderate criteria. This shows that using teaching materials has an influence on student learning outcomes. Other results were also obtained from observations made by researchers and teachers to determine student learning activities with indicators of skills, creativity, critical thinking, communication and collaboration. In line with research Muhali (2019), it is confirm that teaching materials are said to be effective if they can make students more active and creative in learning. The results of observations of teaching materials developed affect student learning activities by obtaining an average observation result of 81.31 with very active criteria. Student responses to teaching materials obtained 92.30% results with a very positive category. Analysis of learning outcomes, learning activities and student responses, all show the effectiveness of teaching materials and practicality of teaching materials.

As for suggestions from practitioners, there are several uses of punctuation, the use of images must be contextual. The response from practitioners as a whole is very interesting, easy

to use and displays something new in the process of finding information on the material being studied. The results of the trial were revised as an improvement step to produce teaching materials that were truly feasible, effective and practical. Some of the trial steps shown in Figure 3 and Figure 4.

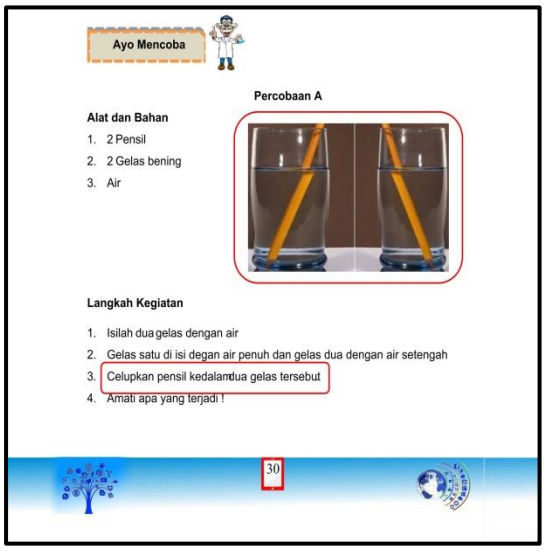

Figure 3. Teaching Material Before Trial Steps

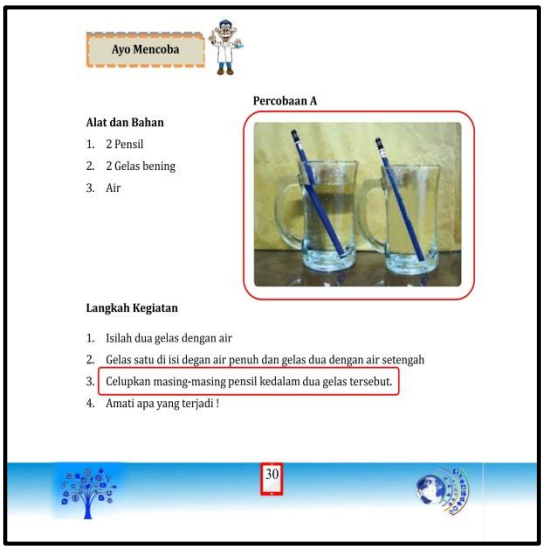

Figure 4. Teaching Material After Trial Steps

The results of the revision of the limited trial shown in Figure 3 and Figure 4 were corrected according to correction from the teacher during the trial, that is on the display of the image of the light experiment activity can be refracted, on Figure 3 shown is not accordance with the steps of the experimental activity which is possible happen misconceptions during learning activities.

The next stage is the implementation process to test widely developed teaching material products. The implementation of teaching materials on a wide scale is carried out in the experimental class and the control class. Treatment in the implementation class by applying pretests and posttests aims to determine the effect of teaching materials on students' interest in learning science. The instrument used is a student interest questionnaire. Indicators of student interest include feelings of pleasure, student interest and student attention (Rozikin et al., 2018). The following are the results of the analysis of student interests which are presented in Table 3, Table 4, Table 5, and Table 6.

Table 3. Control Class Interest Analysis Results

No	Aspect	Pre-nontest	Post-nontest	Difference	N-gain
1	Highest interest score	65.00	68.00	3.00	0.20
2	Lowest interest score	56.00	61.00	5.00	0.21
3	Class average	59.50	64.80	5.30	0.26

Table 4. Experimental Class Interest Learning Results

No	Aspect	Pre-nontest	Post-nontest	Difference	N-gain
1	Highest interest score	71.00	76.00	5.00	0.33
2	Lowest interest score	41.00	65.00	25.00	0.64
3	Class average	56.60	70.21	13.61	0.54

Table 5. Analysis Results *Test Nonparametric Mann Whitney* Student Interests

Aspect	Shiva's Interests
Mann-Whitney U	28.000
Wilcoxon W	119.000
Z	-4.383
asymp. Sig. (2-tailed)	.000
Exact Sig. [2*(1-tailed Sig.)]	.000b

Tabel 6. The Student's Answer Samples on Experimental Class

Indicators	Statement	Responden-1		Responden-2	
		Pretest	**Posttest**	**Pretest**	**Posttest**
Include feelings of pleasure	Science learning material is difficult for me because there are too many observations and experiments.	Agree	Strongly Disagree	Agree	Strongly Disagree
	The teaching materials used in learning science are less fun.	Strongly Agree	Disagree	Agree	Disagree
	I enjoy learning science because I know its use in everyday life.	Disagree	Agree	Agree	Strongly Agree
	I follow science learning with a happy feeling.	Strongly Disagree	Agree	Disagree	Agree
	I am passionate about learning science when the teacher teaches using interesting teaching materials.	Strongly Disagree	Agree	Disagree	Agree
	I am not happy when science learning is taking place in class.	Agree	Strongly Disagree	Agree	Disagree
Student interest	I don't take notes when the teacher is explaining science learning materials	Disagree	Disagree	Disagree	Disagree
	I pay close attention to learning when the teacher is explaining the subject matter.	Disagree	Strongly Agree	Agree	Strongly Agree
	I am less active when discussing in groups.	Agree	Strongly Disagree	Disagree	Strongly Disagree
	I discussed with my group friends the problems encountered in learning science.	Strongly Disagree	Agree	Disagree	Agree
	I am not busy myself when the teacher explains the learning material.	Disagree	Agree	Agree	Agree
	When discussing with groups, I talk to friends outside of the learning material.	Agree	Disagree	Disagree	Strongly Disagree
	I talk alone with my friends when the teacher is explaining science learning material.	Strongly Agree	Disagree	Agree	Disagree

Indicators	Statement	Responden-1		Responden-2	
		Pretest	Posttest	Pretest	Posttest
Student attention	The science assignments given by the teacher made me more interested in science lessons.	Disagree	Strongly Agree	Disagree	Strongly Disagree
	I feel hopeless when working on science questions.	Disagree	Strongly Disagree	Agree	Disagree
	I am interested in doing exercises about science learning.	Disagree	Strongly Agree	Disagree	Strongly Agree
	When I have difficulty understanding science material, I ask the teacher.	Agree	Agree	Agree	Agree
	I procrastinate in doing the science assignment given by the teacher.	Agree	Strongly Disagree	Agree	Disagree
	I'm not interested in science because I'm always doing observations and experiments.	Strongly Agree	Disagree	Agree	Disagree
	I am interested in doing assignments related to science material given by the teacher.	Disagree	Agree	Disagree	Strongly Agree

Based on the analysis of students' interest in learning, it can be seen from the results of giving students' interest in learning questionnaires in the experimental and control classes. The results of the analysis are shown in Table 3. and Table 4., the average N-gain of students' interest in learning in the experimental class reached an average of 0.56 which means they are in the medium category. The N-gain of control class students' interest in learning is 0.26, which means they are in the weak category. This shows that the experimental class obtained an average student interest in learning better than the control class. These results are reinforced by the results of the Mann Whitney Nonparametric Test which are shown in Table 5. The results of the comparative test of student interest in learning with the help of SPSS Version 23 obtained the Asymp Sig value < 0.05, then Ho is rejected.

The achievement indocator of student learning interest can be saw from student's answer sample at class experiment on pretest and posttest which presented in Table 6. In students' pleasure indicator in teaching and learning in the experimental class increased. It can be seen from student's responses from questionnaire about students' feelings when participating in teaching and learning enthusiasm and pleasure. The situation is different when the students did not obtain the teaching and learning process using teaching materials yet. Student responses tend to be unhappy when the science teaching and learning process will begin. So it influenced to the student's perceptions when received science material which always be burden that is very difficult. However, the existence of teaching materials about the nature of light with TPACK can increase students' willingness to learn. This can be seen from the learning process where the students feel happy when participated in teaching and learning activities, both observations and experiments.

The indicator of student attention is the students' concentration or activity on something that be focus their attention on the learning process. The student's attentions to the science teaching and learning in the experimental class showed a change the attitude of attention to the science teaching and learning process in a positive direction. This situation can be seen

from the results of giving questionnaire before and after the treatment. The results of the student's responses after using teaching materials about the nature of light with the TPACK showed the student's attention to the teaching and learning process increased, especially from student's attentions to the material, group or independent activities and attentions to the teacher when explained the material.

On the indicators of student's interests in the experimental class in learning science were so different after students received treatment using developing teaching materials. This situation can be seen from the questionnaire responses given to the students during the pretest and posttest which are presented in Table 6. The condition before the treatment of students tend to be less interested. The Student's responses during the pretest showed that the students were less active in the learning process. For example on the question "The assignments given by the teacher make me more interested in science lessons", and "I am interested doing on science learning questions" get the student responses in a negative direction. After getting the treatment, the student's responses showed a positive increase from disagree to strongly agree. The other responses also showed a change in a positive direction, especially student's interest in teaching and learning which showed by the posttest results where students interested to solve the problems and trying to complete the exercises in the science learning process.

The increase in students' interest in learning shows that students feel motivated when learning to use teaching materials the properties of light charged with TPACK. This is shown from the emergence of feelings of pleasure, interest and attention of students when carrying out learning activities using teaching materials starting from the activities "Let's observe, Let's reason, Let's find out, Let's try, Let's conclude, Let's practice and let's reflect". The feelings of pleasure, attention and interest of students certainly cannot be separated from the concept of presentation design, material/content, and language as well as the concept of TPACK content presented in teaching materials. The design of the presentation of teaching materials is packaged in such a way as to be able to bring out the maximum student effort in the learning process. Design of teaching materials ranging from covers, layouts, tables and letter forms with varied and attractive packaging. Puspita et al. (2014), in their research on the development of teaching materials that are supported by the design of presenting pictures can foster student interest in understanding the material. The design of teaching materials with color gradations that match the material makes students seem to have done something fantasy and has its own charm (Budiningsih et al., 2015). Of course the feeling of pleasure that arises in students when using teaching materials will make students feel happy and like when they see the beauty of teaching materials to carry out something without any burden on students. Jyrki & Millionrat (2014) said the tendency of students when experiencing feelings of pleasure will do things by themselves without any coercion so that learning experiences arise that can change knowledge.

Teaching materials are presented contextually both in terms of examples of pictures and events that are close to the daily life of students in the learning process. Students feel interested and motivated because what they learn is something they usually see, observe and even do in their daily lives. according to Windyarani et al. (2017), contextual learning is a positive thing and is able to answer the questions they have been thinking about in their daily lives. Contextual presentation of teaching materials will increase students' attention in learning where contextual concepts are able to provide structured assistance so that students have a better focus on learning with what is learned. In accordance with Fahreza's (2021), teaching materials that are packaged contextually will make students interested in the learning process independently or in groups.

Science learning which has several scientific consequences includes observing, asking questions, gathering information,

managing information and communicating. This becomes boredom for students in learning which is caused by the lack of clear instructions and instructions so that students seem bored. The presence of teaching materials for the properties of light charged with TPACK becomes a learning guide and can encourage students to be more active and creative in carrying out their efforts to carry out the scientific activities they learn. Students feel that science learning is no longer considered a boring specter with experimental activities that have been considered difficult for students. According to Flowerday & Shell (2015), learning is said to be able to run effectively if students have the drive or motivation for their progress towards what they are learning. The ability of students' motivation or effort in answering problems related to phenomena or students' daily life will certainly bring up new ideas when doing reasoning or experiments.

The TPACK content in the developed teaching materials makes students happier, more interested and increases students' attention when using teaching materials. Teaching materials containing TPACK become a new reference for students when understanding the material using advanced technology. TPACK content is spread in every student activity in teaching materials that are integrated into several TPACK indicators. The technological approach in teaching materials is not just an example of an image but how students understand to use the elements of technology in science learning. In addition to this, the technological components presented in the material also contain various interesting activities in utilizing technology to increase knowledge through searching on web. According to research by Yatmono et al. (2013), learning through the use of web pages has a significant impact on student involvement in various learning activities. In tune with Purwaningsih et al. (2020), stated that the role of ICT is very significant in motivating students to learn independently through web pages. The use of web in this study is not only to find out information but also the web can be presented in the form of pages such as material information links or learning tutorial videos provided by teaching materials. Teaching materials equipped with various link pages can make it easier for students to understand the material and learning activities. The use of links provides a broad space for searching for information for students, both studying independently and in groups and can access learning quickly. Teachers also find it helpful to integrate TPACK, where the teachers are no longer the only source of information in learning as is common in conventional learning.

The concept of teaching materials with TPACK content as a step forward in guiding student activities. According to the results of the interest questionnaire, students feel happy when using the web in the form of tutorial links where students can understand easily when carrying out activities such as observations and experiments. The teacher feels very helpful because the teacher only acts as a facilitator in guiding the student learning process. The student learning evaluation is equipped with a link to the student exercise form so that students feel interested when working and collecting quickly both at school and at home. This is in line with the research of Hariyanto et al. (2020), which states that technological content will motivate students more in using teaching materials when students understand the material.

According to Achru (2019), interest in learning is the driving force in students caused by someone who seeks to gain knowledge and experience. Teaching materials play an important role in helping students in learning activities. Student interest, student attention, and feelings of pleasure are important elements for students in exploring knowledge. A high interest in students to learn will make students feel curious and try to pursue what they don't know (Karina et al., 2017).

Students tend to pay more attention to what makes them happy to search, try and investigate. According to Holbrook and Rannikmae as quoted by Pratiwi et al. (2019), science learning can be improved by cultivating internal components such as attention, involvement and interest to increase knowledge

accompanied by curiosity through scientific activities and being able to communicate in learning so that it creates an optimal contribution to knowledge and the environment. From the analysis and explanation, it is very clear that students' interest in learning using teaching materials, the properties of light charged with TPACK are an important factor in learning science.

CONCLUSION

The development of teaching materials for the properties of light charged with TPACK meets the very feasible criteria according to the results of the validation of experts and practitioners. The teaching materials developed also meet the criteria for being very effective in the trial class as indicated by the results of observing student learning activities, obtaining student learning outcomes and receiving positive responses. The results of the implementation of teaching materials have a significant influence on the results of the implementation of the development of teaching materials on the properties of light charged with TPACK to increase students' interest in learning science. This can be seen from the analysis of N-gain and *Mann Whitney Nonparametric Test* on the learning interest questionnaire, experimental class students obtained better results than control class students.

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